Repair of Nerve Injuries in the Hand

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• Loss of sensation in a finger due to industrial injury is of rather high incidence as a cause of disability. In many cases "finger blindness" can be prevented by nerve repair immediately after injury. Over a period of three years at a clinic for treatment of industrial injuries, primary nerve repair resulted in 95 per cent of cases in usefully functioning digits.

REPORTS ON INJURY to nerves in the hand are scarce. Yet industrial trauma of this type occurs with considerable frequency. A tabulation of permanent disability awards in Southern California discloses that in 1 to 2 per cent of cases the claim for compensation is based on sensory loss following finger injury. In some digits nerve injury is rated equal to amputation. "Blind," feelingless fingers are not only useless but hazardous. The demands of our modern precision industry cannot be met by atrophied, numb, lifeless, claw digits. Such hooks are exposed to the risk of constant re-injury and to the development of trophic ulcers and general deterioration. The situation is aptly expressed by the patient who states: "It's no good—you might as well cut it off."

A review of the records of an industrial clinic at which the author practices, covering nerve injuries to the hand during the past three years, shows that all classifications of industry are represented. In about 90 per cent of cases the common volar digital nerves were involved; the proper volar digital nerves in 5 per cent; the superficial branches of the radial and ulnar nerves in 3 per cent; the thenar motor branch in 1 per cent; and deep branches of the ulnar nerve in 1 per cent. Other smaller nerves were not tabulated.

This presentation is primarily concerned with the management of injuries to the common volar digital nerves, since they make up the bulk of cases. But the principles which will be presented are also applicable to all other nerves of the hand.

The pyramiding incidence of "blind" fingers can be halted by primary nerve repair. A freshly injured hand is essentially a healthy hand, in contrast to a convalescing, congealing appendage. Operation on a well nourished hand is followed by rapid healing. Peripheral sensory nerves resist infection and heal by first intention, as long as the adjacent tissues have not undergone atrophy. Psychologically the patient will never be more readily willing to consent to an operation than immediately after the accident. The longer the time after the injury, the greater the patient's resistance to secondary repair. Restitution of normal anatomic relationships by immediate operation cuts the time lost off the job almost in half, while it does not add to the discomfort connected with the merely temporizing procedure of closing the wound.

The method of treatment here described, while not original, is the result of experience with a considerable number of such nerve injuries at the clinic.

The majority of disabilities are due to direct or indirect physical forces acting on the nerve and causing contusion, partial severance or complete division. Injury may be produced by sharp cutting instruments such as knives and tin; semi-sharp spinning tools, such as power saws and emery wheels; or by the blunt, contusing, tearing impact of objects like punch presses and falling castings.

Sharp cutting injuries usually result in a clean division of the nerve. If, however, the injury occurred while the nerve was in a stretched position, the ends may be frayed. Semi-sharp spinning forces cause nerve fraying distal and proximal to the wound. A moderate amount of bony and soft tissue destruction accompanies such an injury. Blunt, contusing, tearing trauma presents the major problem, since a considerable length of the nerve may be lost, the soft tissue compressed to a disorganized pulp and the bony tissues distorted. What remains of the nerve is usually contused, hyperemic, frayed and edematous. Occasionally the cut ends are hemorrhagic and thrombotic, suggesting a ruptured vessel (Figure 1).

Normally, the nerve is pinkish-white (Figure 2). Upon cross section, axons and a sheath of tissue paper thickness, traversed by longitudinal small blood vessels, can be grossly observed. The nerves course along the lateral volar surfaces of the fingers; together with the accompanying arteries and veins they form neurovascular bundles which measure approximately one-eighth of an inch in diameter (Figure 3). Surrounding soft tissues do not only protect the bundle but can be extremely effective in concealing its structures by folding over the cut and retracted vessels and nerve endings.

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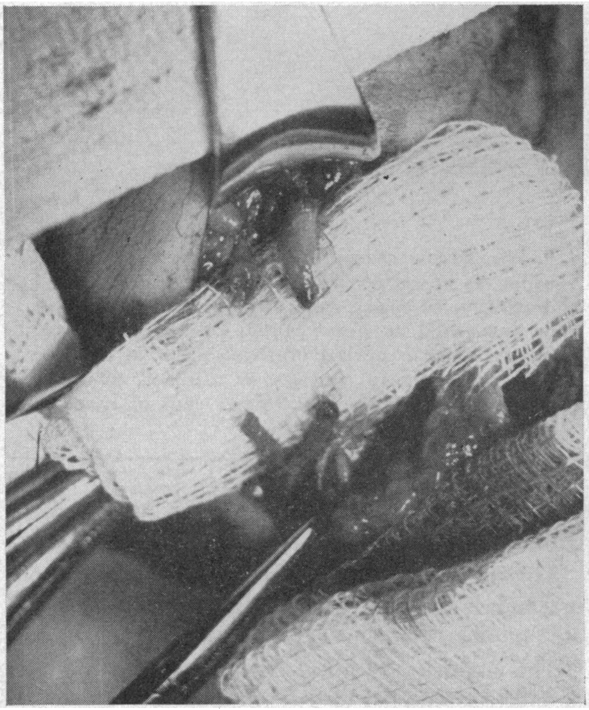

Figure 1.—Dorsum of hand photographed a half hour after injury. Several sensory branches of the ulnar nerve are contrasted by the sponge. Some of the lacerated nerve ends are covered by thromboses from the vessels of the sheath, which make the nerve end appear as if it were a thrombosed vessel.

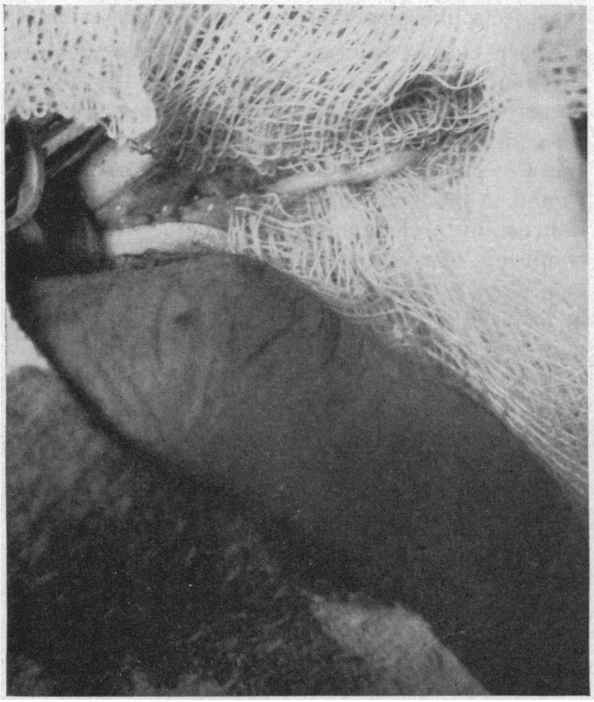

Figure 2.—Normal common volar digital nerve in the live hand, exposed and separated from the artery and vein. The nerve is glistening pinkish-white and round, but slightly flattened on the dorsal and palmar aspects. The size of the nerve may be gauged by comparing it with the mesh of the underlying gauze sponge.

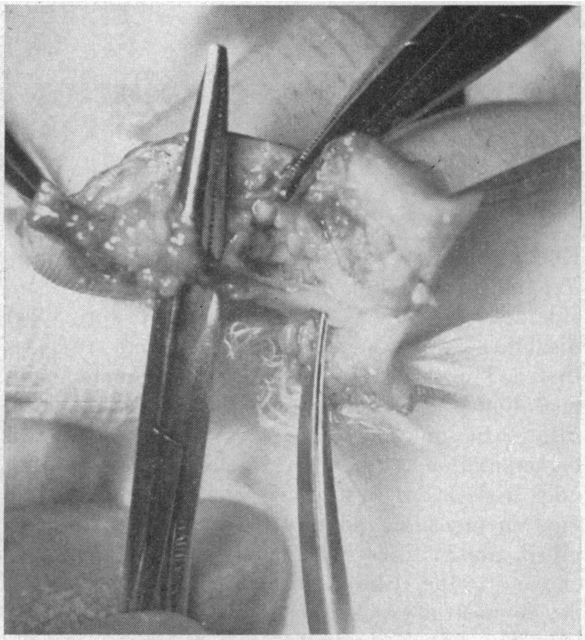

Figure 3.—Neurovascular bundle just proximal to the distal flexion crease in the freshly injured hand. The intimate relationships and gross similarity of artery, vein and nerve are shown. Note the blending of soft tissues and neurovascular bundle.

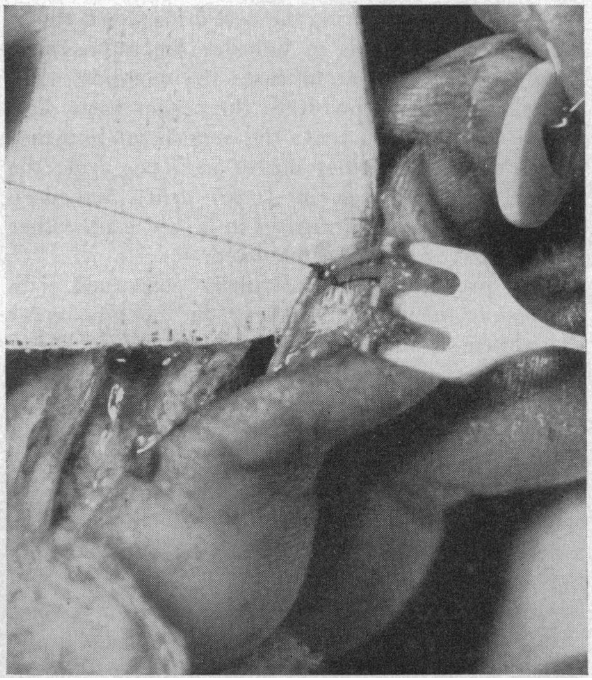

Figure 4.—Common volar digital nerve, repaired distal to the distal flexion crease. At this point the nerve branches are sending an inferior twig to supply the pulp, and a superior twig to the nail bed. These divisions have been sutured to the main trunk. Number 6-0 silk hold sutures have been placed; the palmar surface has then been rotated dorsally in order to facilitate suture of the volar portion of the nerve. The vessels of the neurovascular bundle can be seen inferior to the retracted nerve. Extension of the wound along the dorsolateral aspect of the finger is demonstrated.

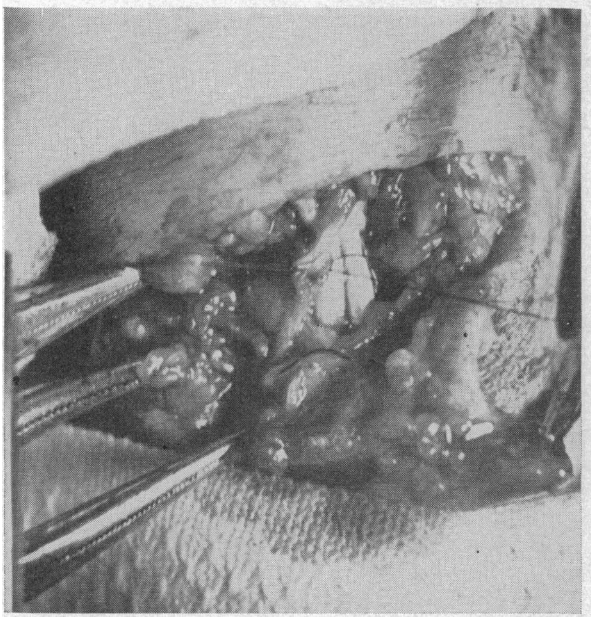

Figure 5.—Two guy sutures have been placed and rotated so that the palmar surface of a superficial branch of the ulnar nerve becomes dorsal. Extensor tendons to the little finger are seen deep to the nerve.

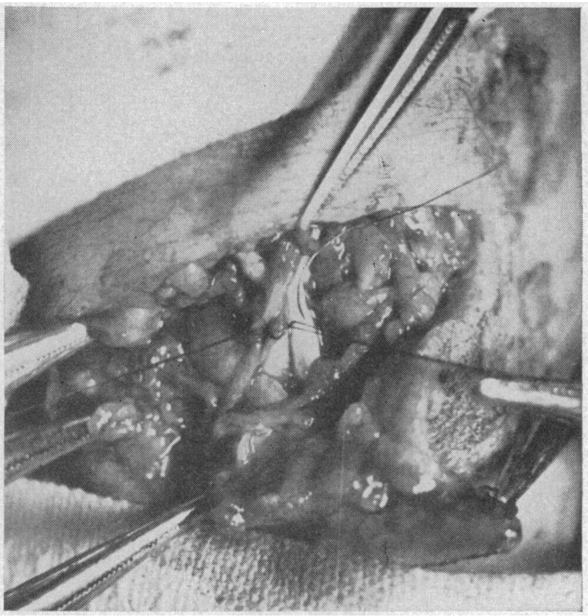

Figure 6.—Approximation of the neurilemma is completed by interrupted sutures placed between the steadying sutures. Number 6-0 silk in an atraumatic needle can be seen passing through the sheath of an unrepaired nerve. The needle lies on an extensor tendon.

Complex surgical problems are likely to arise when such small and intimate structures are subjected to trauma. At the time of operation the vessels appear white, thus simulating nerves, while the blood vessels coursing along the nerve sheath may be thrombosed, suggesting volar vessels. Usually these components are mingled with the soft tissues, and may be further disguised by the interposition of tendons and fractured bone.

Nerve repair must have top priority in all injuries to the hand. If, for some reason, primary repair is deferred, the nerve ends should be secured to one another by a fine stainless steel wire to prevent nerve shortening before the time of secondary repair. Primary repair may be performed up to six or eight hours after injury. The more proximal the site of severance, the easier the repair. It is generally recognized that when the injury is beyond the distal flexion crease, nerve repair should not be attempted. However, if the nerve trunk is of sufficient diameter to accommodate one or two sutures, approximation is in order (Figure 4).

All cases of injury to the digits are appraised for possible nerve damage by sensory tests. Usually a digital nerve block proximal to the wound suffices, but occasionally a median and/or ulnar nerve block may be indicated. Surgical technique must be exact in every detail. The entire hand and arm are washed for five minutes with Gamophen® soap, particular attention being given to the wound. The extremity is then draped in the accepted manner, and a tourniquet is applied. Meticulous wound debridement under avascular conditions follows. Extension of the wound along the lateral borders of the finger insures adequate exposure (Figure 4).

The nerve ends are rarely exposed, and a methodical search for them is usually required. This is best done with sharp, pointed, curved scissors, used in a spreading fashion; they are applied one-half inch proximal and distal to the wound, parallel to the neurovascular bundle. The nerve is then identified and separated from the vessels (Figure 2). At each of the nerve ends a minimal length of the strand is resected at a time, until normal tissue is reached. The cut section shows a sharply defined neurilemma, and the lumen contains a bristling core of axons; these findings serve as the ultimate differentiation between nerve and vessels. Trial approximation is then attempted. If the ends do not meet, additional nerve fiber must be mobilized. This maneuver is kept to a minimum, since excessive separation of the nerve from its surroundings would interfere with vascularization. Any further nerve gaps may be closed by finger flexion. The suturing should be done when a relaxed approximation has been attained; No. 6-0 silk on an atraumatic needle is run through fatty tissue to straighten kinks and insure a freely gliding suture.

The first suture is passed only through the neurilemma, and as close to the cut edge as feasible. The directly opposite sheath is caught by the same suture, matching corresponding sheath vessels and axons. The suture is then tied and held by a small hemostat.

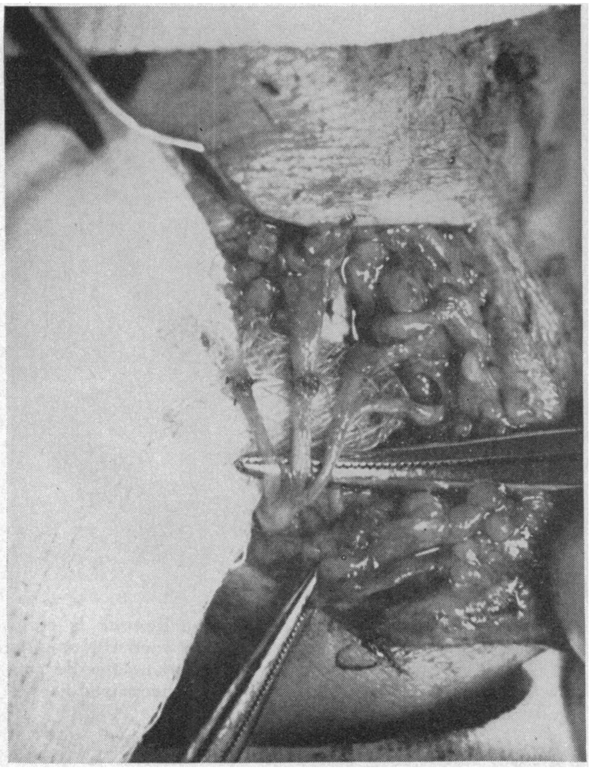

Figure 7.—Final suture has been accomplished. Knots are cut flush. Sheaths and axon bundles are aligned. The juncture sites still appear moderately rough as compared to an uninjured branch (right). A hemostat exerts traction; it is then slid proximally and distally over the suture sites, and the surgeon's index finger rolls the juncture area against the surface of the hemostat. Final and accurate apposition of axon to axon and sheath to sheath is attained through these maneuvers.

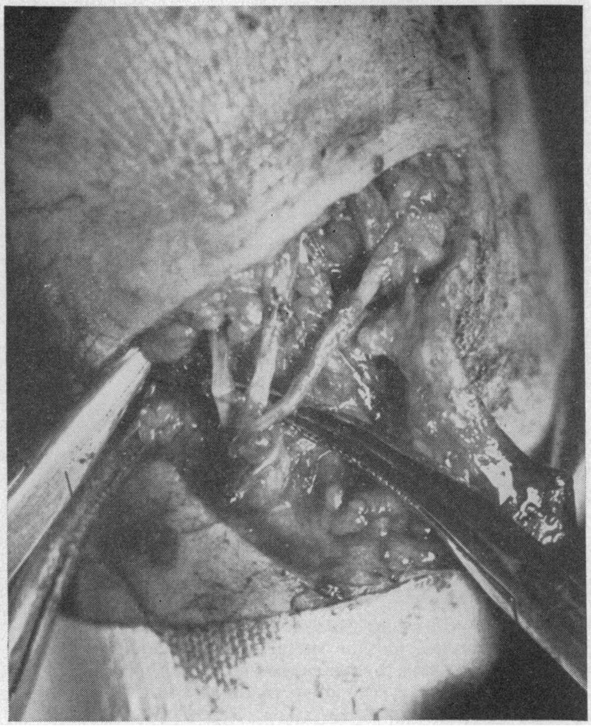

Figure 8.—Wound ready for closure. The sutured nerve branches are now uniform in size. The juncture sites are smooth and present no openings through which axons can escape. Fatty tissue has been mobilized to separate tendons from nerves. The site of nerve repair is enveloped by areolar tissue.

An identical suture is placed diametrically opposite the first one, and secured by means of a hemostat. The nerve is now stabilized and two or more sutures are easily placed, tied and cut at the knot. (See Figures 5 and 6.) One of the holding hemostats is passed under, the other one over the nerve, rotating the dorsal aspect toward the palmar side. This permits easy suturing. All sutures are cut flush at the knots, and the juncture site is rolled over a blunt hemostat to insure accurate approximation of neurilemma and alignment of axon bundles (Figure 7). Inaccurate closure of the sheath invites distal probing axons to escape and form painful neuromata.

Soft fatty tissue mobilized about the suture site prevents troublesome adhesions and affords protection against moving parts (Figure 8). The skin is closed by interrupted stainless steel wire sutures placed at a distance from the nerve. A fluff gauze dressing and a stockinette cut on the bias provide adequate counter pressure. The tourniquet is then released. A volar plaster splint keeps the digit fixed in a position of function to prevent nerve tension. Antibiotic and antitetanic therapy is now begun. Patients are treated while ambulatory. Dressing and splint are not disturbed for three weeks, unless to do so becomes necessary for clinical reasons. After removal of sutures, restricted motion of the finger is permitted. Nerve regeneration begins within eight to ten weeks, as demonstrated by return of sensation, and reaches its maximum after one year.

In most cases here reviewed the postoperative course was uneventful, and there were no instances of infection or of silk suture slough. All wounds healed per primam. Coarse touch sensation and response to painful stimuli began to reestablish themselves after eight to ten weeks. Somewhat later, light touch perception was recovered in most patients, but remained lacking in a few. After one year most patients were again capable of stereognostic sensation, but about one in ten complained of some degree of numbness. In 95 per cent of cases nerve repair resulted in usefully functioning digits; in the remaining 5 per cent loss of soft tissue and bone had been too extensive to permit adequate restoration of function. Neuromata were rare, and they occurred only in cases in which trauma was of the blunt, contusing, tearing type.

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